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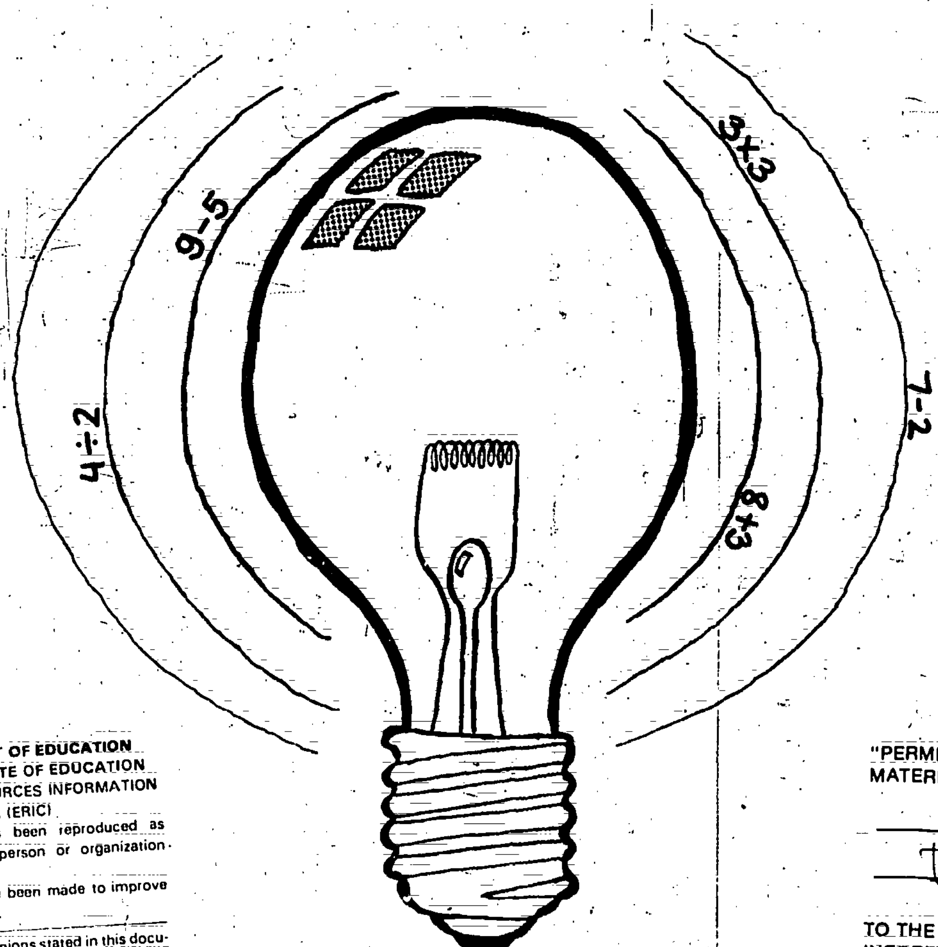
ABSTRACT

This curriculum guide, one of 15 volumes written for field test use with educationally disadvantaged industrial education students needing additional instruction in the basic skill areas, deals with helping students develop basic mathematics skills while studying electronics. Addressed in the individual units of the guide are the following topics: reading a ruler, measuring and monitoring energy consumption, using the correct meter scale, finding voltage drops in a series circuit, converting electrical units, using mathematical formulas, and using scientific notation. Each unit contains some or all of the following: a discussion of the major concepts of the technique being covered, instructions to the teacher concerning the use of the given technique, suggested related activities, student instructions, a student assignment, supplemental activities, and one or more worksheets. A basic skills checklist and a basic skills verification form are also provided to assist teachers in identifying those students who require additional help with basic skills. (MN)

"LEARNING TO DO MATH THE ELECTRONICS WAY"



DEVELOPED BY

THE EDUCATIONALLY DISADVANTAGED COMMITTEE

INDUSTRIAL EDUCATION INSERVICE PROJECT

in cooperation with

The California State Department of Education

Office of Vocational Education
Field Operations Section
Industrial Education Unit

and

California State University - Los Angeles
Industrial Studies Department

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INSTRUCTIONAL TECHNIQUES

INTRODUCTION

These instructional techniques were developed for those industrial education students who demonstrate a need for additional instruction in the areas of reading, writing, math, verbal and visual communication. They were written by industrial education teachers with a particular emphasis upon teaching a basic skill while retaining a major focus on the subject areas of auto, woods, metals, electronics, and drafting.

Each of these instructional techniques were written using the same format and with guidance from an expert in the areas of reading, writing, math, verbal and visual communication.

In order to help you identify those students who require additional help with the basic skills, a simple easy-to-use BASIC SKILLS CHECKLIST is provided with each subject area module. This Basic Skills Checklist will enable you as the Industrial Education Teacher to better identify those students in your classes who require additional help in the basic skills.

Additionally, a BASIC SKILLS VERIFICATION FORM is provided which will enable you to ask your school's reading resource teacher, basic skills teacher, math resource teacher, Hart Bill Conferencing teacher, or grade counselors, to verify your identification and provide you with help in the instruction of the basic skills.

You may wish to use these techniques as instruction for your entire class, or as a take-home, parent-involvement assignment. They may also be used in your school's reading or math lab or in conjunction with your school's basic skills instructional programs.

These instructional techniques are successful because your students are able to relate reading, writing, math, verbal and visual communication to their own industrial education classes. When your students succeed, they feel good about themselves, good about their schools, and good about their future.

CONFIDENTIAL

Name ______________________

Grade ________ Class ____________

Date ______________________

BASIC SKILLS CHECKLIST (ELECTRONICS)

The following is a list of the basic skills (reading, writing, math, verbal and visual communication) that the student should demonstrate an ability in for the purpose of employment or advanced training in the electronics trades.

1.0 *Verbal Communication:* The student needs additional instruction in verbal communication if any of the items below are checked NO:

1.1 Yes ___ The student understands verbal directions or information given by the teacher.

No ___ *Example:* The teacher informs the student that electrical power must be turned off when making electrical connections. Does the student follow verbal instructions as required? Does the student follow safety rules as required? Does the student turn the power switch to "off"?

1.2 Yes ___ The student asks questions about instructions or information not understood.

No ___ *Example:* Did the student ask questions about the operation of an oscilloscope if it appears that the verbal instructions were not clearly understood?

1.3 Yes ___ The student is able to apply information and directions heard to
No ___ work situations.

1.4 Yes ___ The student is able to verbally communicate with the teacher and other students.

No ___ *Example:* Is the student able to convey instructions or information on how to etch printed circuit boards?

2.0 *Writing:* The student needs additional instruction in writing if any of the items below are checked NO:

2.1 Yes ___ The student is able to summarize and write a customer work order.

No ___ *Example:* A customer complains of "no picture and no sound" on a television receiver; is the student able to convey this problem and suggest corrective procedures in writing on the customer work order?

2.2 Yes ___ The student is able to communicate in writing instructions for a job to be performed.

No ___ *Example:* Is the student able to write a step-by-step procedure for measuring resistance using a volt-ohmeter?

2.3 Yes ___ The student is able to write a report on the operational function of an electronic component or project.

No ___ *Example:* Is the student able to describe, in writing, how a fullwave bridge rectifier power supply works?

3.0 *Reading:* The student needs additional instruction in reading if any of the items below are checked NO:

3.1 Yes ___ The student is able to read and understand job related materials.

No ___ *Example:* Is the student able to read and understand reference

manuals, safety rules and regulations, specifications, etc?

3.2 Yes ___ The student is able to follow step-by-step procedures on an instruction or job sheet.

No ___ Example: In constructing electronic projects, the student fails to follow the assembly instructions.

3.3 Yes ___ The student is able to read and understand current state of the art developments from periodicals and newspapers.

No ___ Example: The student is requested to read an article from the magazine POPULAR ELECTRONICS. Is the student able to relate both general and specific details from the article?

4.0 Math: The student needs additional instruction in math if any of the items below are checked NO:

4.1 Yes ___ The student is able to perform simple arithmetical operations i.e., addition, subtraction, multiplication and division of whole numbers, decimals and fractions.

No ___ Example: Is the student able to make simple computations that are common to electronics; total voltage drop in a series circuit.

4.2 Yes ___ The student is able to convert exponents to fractional equivalents and metric units.

No ___ Example: Is the student able to understand common conversion units, i.e., 10^{-3}= Milli = 1/1000 ?

4.3 Yes ___ The student is able to compute formulae which requires the use of decimals, squared numbers, multiplication and division.

No ___ Example: Is the student able to apply mathematical concepts to common electronics formulae, i.e., Ohm's Law and Kirchoff's Law.

4.4 Yes ___ The student is able to compute percentages and ratios.

No ___ Example: Is the student able to make simple mathematical computations applied to common electronics concepts? i.e. percentage of tolerance for resistors.

4.5 Yes ___ The student is able to read a ruler and make linear measurements.

No ___ Example: Is the student able to transfer dimensions from a scaled drawing to an actual chassis?

4.6 Yes ___ The student is able to compute hourly rate, multiplied by the number of hours worked to determine the weekly take-home pay.

No ___ Example: A first-year apprentice electrician earns 40% of the journeyman electrician hourly rate of $14.60. The apprentice works a typical 40-hour week, 10% of the pay is withheld for union dues and fringe benefits, 22% is withheld for state and federal income tax. What is the apprentice's net weekly pay?

5.0 Visual Communication: The student needs additional instruction in visual communication if the item below is checked NO:

5.1 Yes ___ The student can communicate to self and others with simple sketches or drawings.

No ___ Example: Is the student able to draw or sketch an item they wish to construct?

Identification Made By: ______________________ Date ____________

BASIC SKILLS VERIFICATION FORM

Student ________________________________ Male_____ Female_____ Grade Level_____

Teacher ________________________________ Class______________ Date____________

The Basic Skills Check List (attached) for the above student indicates a need for instructional assistance in the basic skills (reading, writing, math, verbal or visual communication). The following verification and recommendations are made:

_____Lacks Reading Skills

_____Lacks Writing Skills

_____Lacks Mathematical Skills

_____Lacks Verbal Communication Skills

_____Lacks Visual Communication Skills

METHOD USED FOR VERIFICATION

Recent Test Scores:

Test	Score	Date

Other Verification Methods:

____

____

RECOMMENDATIONS

The following instructional assistance is recommended: ____________________

____

Verification & Recommendations Made By: ____________________ Date: ____________

Title: ____________________

____

____

FOLLOW UP

Action Taken: ____

Results: _____Qualified for advanced training

_____Qualified for employment in the trade

_____Other ____

Certified by: ____________________________ Date: ____________
Teacher

HOW TO READ A RULER

(Reading A Ruler)

Electronics Math 1

HOW TO READ A RULER

TEACHER MATERIALS:

1. CONCEPTS OF TECHNIQUE:

a. What SKILL will this technique teach?

This technique will teach the use of the standard U.S. ruler. It will also acquaint the student with the use of simple fractions.

b. What student learning problem(s) prompted the development of this technique?

Many students enrolled in electronics classes have not had the opportunity to use the ruler.

2. TEACHER INSTRUCTIONS FOR THE USE OF THIS TECHNIQUE:

a. Make your regular presentation on the use of the ruler.

b. Give a post-test to all students.

c. For those students who had difficulty, have them ask one of their parents to help them complete the accompanying material.

3. SUGGESTED RELATED ACTIVITIES:

Ask your students to practice reading the ruler at home with their parents help

HOW TO READ A RULER

STUDENT MATERIALS:

1. STUDENT INSTRUCTIONS:

a. Take the attached materials home and ask one of your parents to help you learn to read the ruler.

b. Study the material carefully and then determine the measurements on the How to Read a Ruler worksheet.

c. When you have completed the worksheet, have one of your parents sign at the bottom of the sheet indicating that they have helped you learn the use of the ruler.

d. The material in this packet will help you learn how to use the ruler.

2. STUDENT ASSIGNMENT:

Your assignment is found on STUDENT PAGE 3.

3. EXTRA THINGS THAT YOU CAN DO:

Look for various objects in your home that you can measure for additional practice. Examples: width and length of a table; how high is the kitchen chair?

HOW TO READ A RULER

The standard U.S. ruler is usually 12 inches long and each inch is divided into 1/16th, 1/8th, 1/4th or 1/2 inch marks. These units of measure are shown by markings, the sixteenths being the smallest, and the half-inch mark the largest. Here are some common equal measures shown in fractions:

$$\frac{2}{16} = \frac{1}{8}$$

$$\frac{4}{16} = \frac{2}{8} = \frac{1}{4}$$

$$\frac{6}{16} = \frac{3}{8}$$

$$\frac{8}{16} = \frac{4}{8} = \frac{2}{4} = \frac{1}{2}$$

$$\frac{10}{16} = \frac{5}{8}$$

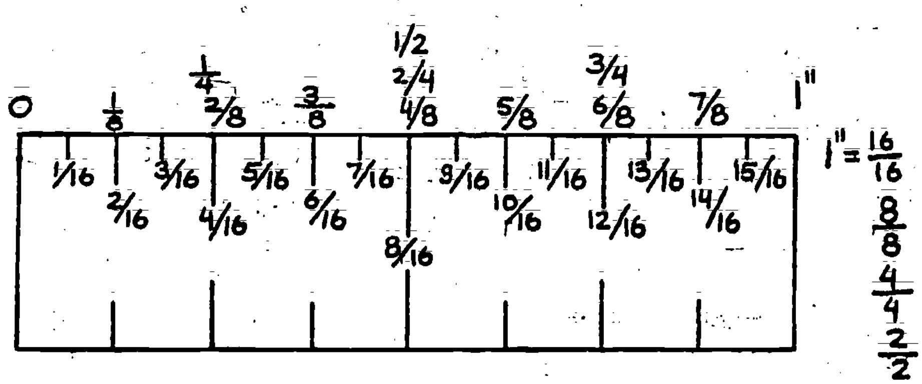
$$\frac{12}{16} = \frac{6}{8} = \frac{3}{4}$$

$$\frac{14}{16} = \frac{7}{8}$$

Note that each fraction is always divided by 2, so that the fraction is reduced to its lowest terms.

Example: $\frac{4}{8} \div \frac{2}{2} = \frac{2}{4} \div \frac{1}{2}$

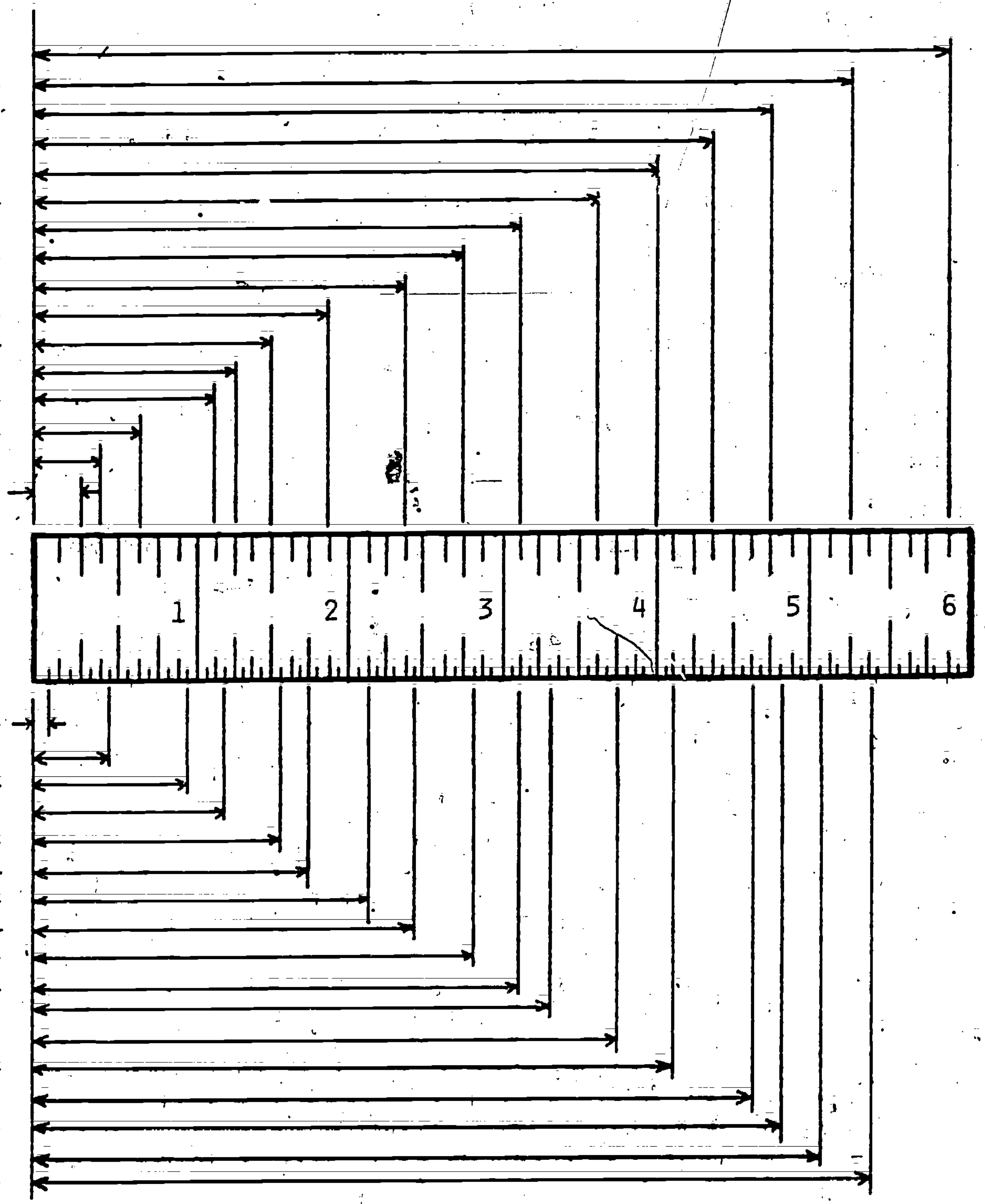
$$1'' = \frac{2}{2} = \frac{4}{4} = \frac{8}{8} = \frac{16}{16}$$



HOW TO READ A RULER

Fill in the measurements for numbers 2 through 33 below. Number 1 is completed for you.

1. $5\frac{7}{8}''$
2. ______
3. ______
4. ______
5. ______
6. ______
7. ______
8. ______
9. ______
10. ______
11. ______
12. ______
13. ______
14. ______
15. ______
16. ______



17. ______
18. ______
19. ______
20. ______
21. ______
22. ______
23. ______
24. ______
25. ______
26. ______
27. ______
28. ______
29. ______
30. ______
31. ______
32. ______
33. ______

Parent's Signature______________________________ Date__________

STUDENT PAGE 3

1.4

NUMBER BINGO

(Fractions/Decimals)

Electronics Math 2

NUMBER BINGO

TEACHER MATERIALS:

1. CONCEPTS OF TECHNIQUE:

a. What SKILL will this technique teach?

This technique will help students to read common fractions and decimals correctly.

b. What student learning problem(s) prompted the development of this technique?

Students cannot read fractions or decimals.

2. TEACHER INSTRUCTIONS FOR THE USE OF THIS TECHNIQUE:

a. This exercise can be used as a warm-up activity to get your students thinking about decimals. For example, it could be used prior to a lesson on scientific notation.

b. This technique is a bingo game where you read off a fraction or decimal and your students have to recognize these numbers.

c. Before playing the game discuss briefly with your class 10ths, 100ths and 1000ths and decimal place values (.1, .01, .001).

d. Explain to your students how to play bingo. Make sure when your students draw a line through the number on their cards that they do not cross out the number completely.

e. Reproduce these sample bingo cards or make your own.

f. Cut up the "numbers to be read off" for easy use in the bingo game.

g. In order to arouse student interest in the game you may want to offer a "prize".

3. SUGGESTED RELATED ACTIVITIES:

Make up more bingo games using different fractions and decimals.

NUMBER BINGO

STUDENT MATERIALS:

1. STUDENT INSTRUCTIONS:

a. You are going to be playing a bingo game. As your teacher calls off a number find it on your card and draw a line through the number as it is read.

b. Play until you fill up one row or column of numbers.

2. STUDENT ASSIGNMENT:

These are the fractions and decimals that will be read off in the bingo game:

$\frac{1}{10}$	$\frac{53}{1000}$	.57	$\frac{236}{1000}$	1.589
$\frac{3}{10}$	$\frac{21}{1000}$	.095	.93	3.730
$\frac{9}{10}$	.36	.176	.234	9.806
$\frac{1}{100}$	.4	1.57	.456	.02
$\frac{35}{100}$	.7	3.79	.698	.078
$2\frac{129}{1000}$	.39	5.863	.999	.492
.001	.050	.003	2.469	.767

3. EXTRA THINGS THAT YOU CAN DO:

Play the game again and ask your teacher if you can read the numbers to the class.

SAMPLE BINGO CARDS

$\frac{1}{10}$	.02	.39	.57	$\frac{35}{100}$
$2\frac{129}{1000}$	.003	.050	.698	.078
.234	3.79	FREE	$\frac{53}{1000}$	$\frac{9}{10}$
.095	9.806	$\frac{1}{100}$	.36	3.730
1.589	.767	.492	$\frac{21}{1000}$	2.469

.698	1.589	$\frac{1}{10}$	.001	.003
.02	$\frac{35}{100}$	.57	.999	$2\frac{129}{1000}$
.7	.93	FREE	$\frac{3}{10}$	.050
$\frac{236}{1000}$	.767	.176	.456	.078
1.57	5.863	$\frac{9}{10}$	3.730	$\frac{1}{100}$

SAMPLE BINGO CARDS

.4	2.469	$\frac{21}{1000}$	1.589	.02
$\frac{236}{1000}$	$\frac{1}{100}$	3.730	.36	.492
.095	.999	FREE	$\frac{9}{10}$	2.469
$\frac{3}{10}$	1.57	9.806	$\frac{53}{1000}$	$2\ \frac{129}{1000}$
3.79	.767	.078	.003	.050

Measuring And Monitoring Energy Consumption

(Reading Meters And Scales)

Electronics Math 3

MEASURING AND MONITORING ENERGY CONSUMPTION

TEACHER MATERIALS:

1. CONCEPTS OF TECHNIQUE:

a. What SKILL will this technique teach?

This technique will teach how to read meters and scales.

b. What student learning problem(s) prompted the development of this technique?

Students very often have difficulty reading meters and scales. They are also uncertain about how to set up math problems to compute total costs from hourly rates.

2. TEACHER INSTRUCTIONS FOR THE USE OF THIS TECHNIQUE:

a. Teach your regular lesson on meters and meter reading.

b. Explain how the power company keeps track of electrical usage. (kilowatt-hours)

c. Explain how electric energy costs are computed.

d. Show examples of several types of kilowatt-hour meters.

e. Explain how a typical meter is read.

f. Give this packet on MEASURING AND MONITORING ENERGY CONSUMPTION to those students that had difficulty with the regular lesson. Read the Information Handout sheet to these students.

g. Have the students complete the exercise on STUDENT PAGE 3. Check their answers in class.

h. Have students take home their packet and with the help of their parents complete the assignment on STUDENT PAGE 5.

3. SUGGESTED RELATED ACTIVITIES:

You may with to reinforce the skills learned in this technique with a follow-up assignment having the students read their gas or water meters and compute the cost of these utilities.

MEASURING AND MONITORING ENERGY CONSUMPTION

STUDENT MATERIALS:

1. STUDENT INSTRUCTIONS:

a. Take this packet home and ask one of your parents to help you learn to read the electric meter in your home.

b. When you have completed the assignment on the last page, ask one of your parents to sign this sheet, showing that they have helped you complete this assignment.

2. STUDENT ASSIGNMENT:

a. Review the information on STUDENT PAGES 2, 3 AND 4.

b. Follow the instructions found on STUDENT PAGE 5 and answer the questions.

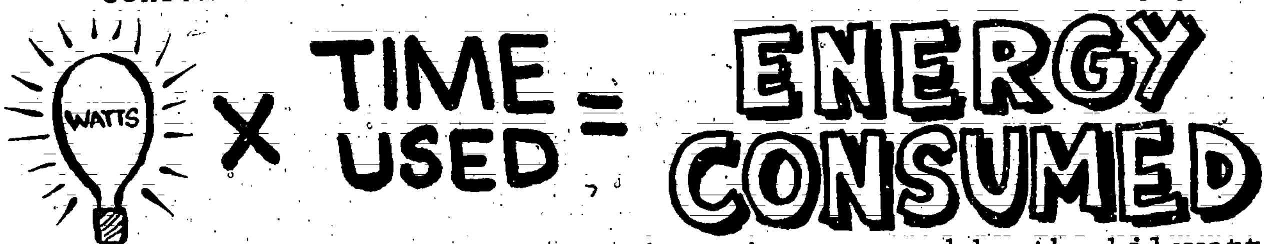
3. EXTRA THINGS THAT YOU CAN DO:

In this lesson you have practiced reading your electric meter. Using these same skills you can also read your water and gas meters. Try reading these meters. You might want to record these readings over a 30 day period. Then you can compare your readings with those on the utility company's bill.

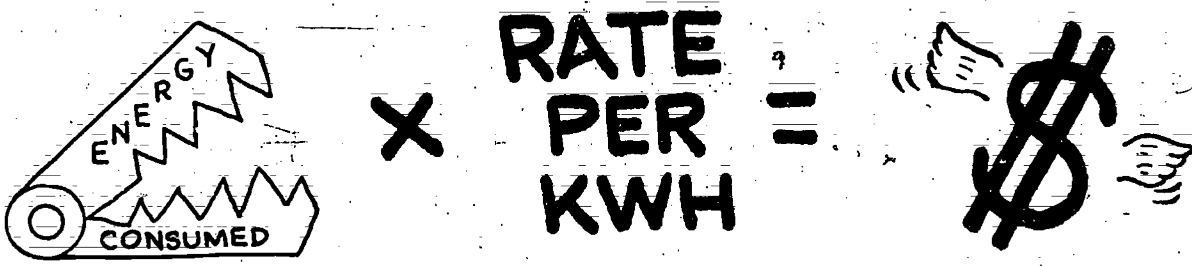
INFORMATION HANDOUT

MEASURING AND MONITORING ENERGY CONSUMPTION

Wattage ratings printed on light bulbs and appliances indicate the rate at which the device uses electric energy. If you know the speed of a car, and the time operated, you can find the distance traveled. In the same way if you know the rate at which electrical energy is used, and for how long, you can find the total energy consumed.



The energy consumed in your home is measured by the kilowatt-hour meter (kwh), which is monitored by the local power company. The power company in turn computes your monthly electric bill based upon the number of kilowatt-hours of energy consumed and the rate schedule which prices each kilowatt-hour.



READING THE KILOWATT-HOUR METER

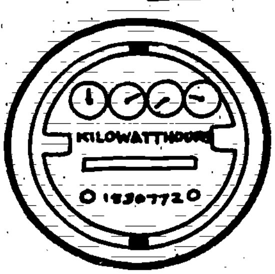


FIG. 1

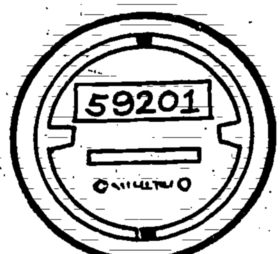


FIG. 2

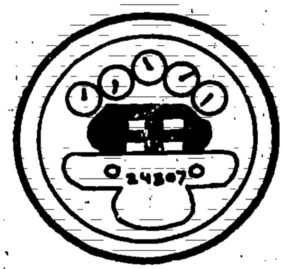
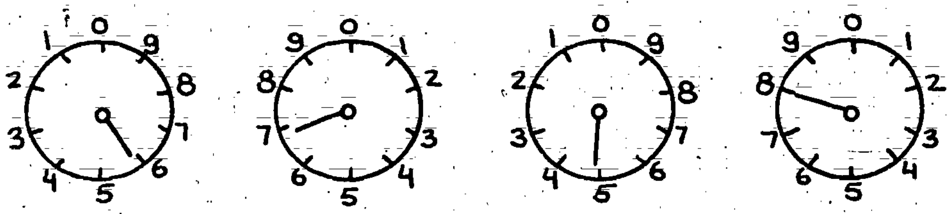


FIG. 3

The drawing above shows several styles of kilowatt-hour meters. Locate your meter at home; however, it may be different from those pictured.

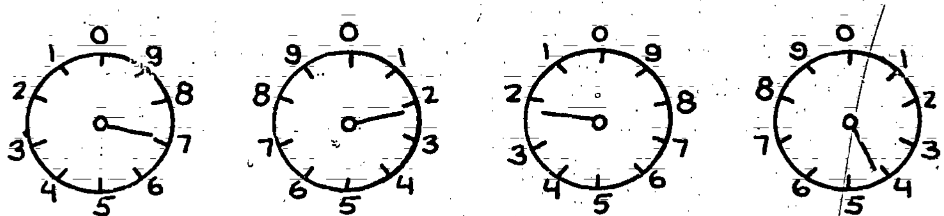
Reading the meter in Fig. 2 is a simple matter, but reading the pointer style meter is slightly more complicated.



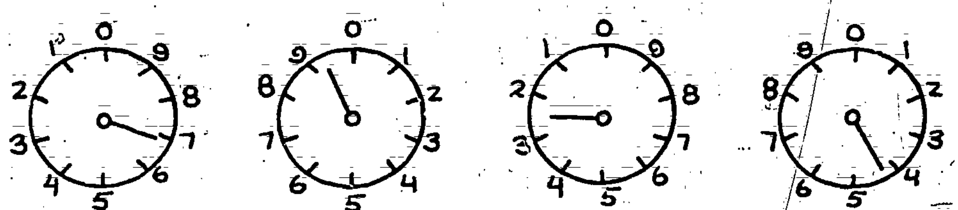
Thousands Hundreds Tens Ones

The meter pictured above is indicating a reading of 5648 kwhs. Notice: even though the pointer falls between two numbers, you always read to the lower value. Also, each dial corresponds to a place value in our numbering system (ones, tens, hundreds, etc.).

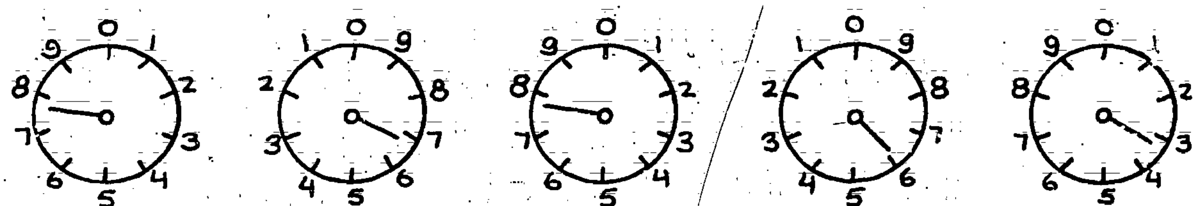
What reading is indicated on the kwh meters below:



Reading__________



Reading__________



Reading__________

ANSWERS: (1) 7224 (2) 6924 (3) 76763

COMPUTING ELECTRIC ENERGY COSTS

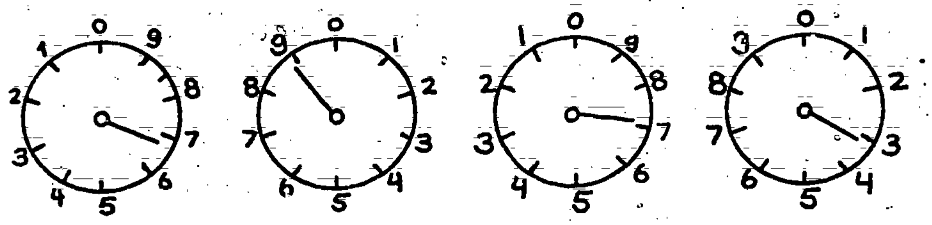
Being able to read the kwh meter is only part of the process in determining monthly energy costs. We will now examine how a power company computes your monthly electric bill.

Step 1. Determine the number of kwhs used per billing period by subtracting the beginning meter reading from the ending meter reading.

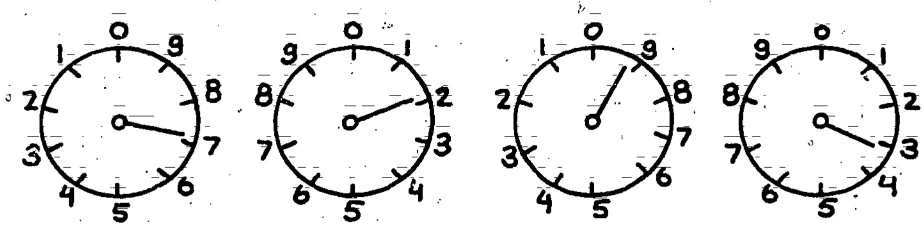
Step 2. Using the rate schedule below calculate the cost by multiplying the number of kwh by the cost per kwh. Total the charges to find total cost.

EXAMPLE: Meter Reading:

Beginning of billing period:



End of billing period:



Rate Schedule:

Fixed customer charge $1.60
Energy charge (includes energy cost adjustment)
First 240 kwh, per kwh . . . . $ .06
Over 240 kwh, per kwh . . . . $ .09

Step 1. Determine the number of kwhs used.

End of period reading	7193
Beginning of period reading	-6873
Difference	320 kwhs

Step 2. Calculate cost using rate schedule.

Fixed customer charge.	$ 1.60
First 240 kwh, at $ .06 each (240 x .06).	$14.40
Over 240 kwh, at $ .09 each (80 x .09). .	$ 7.20
Total. .	$23.20

You and your parents are to follow the steps below. By following them you will learn to measure the amount of electricity that was used at home.

1. Go to your electric meter and record the reading in the box marked 1st reading.

2. Wait 24 hours and read the meter a second time. Record this reading in the box marked 2nd reading.

3. Subtract the 1st reading from the 2nd reading. This will give you the power (kwh - kilowatt-hours) used in 24 hours.

Subtract	2nd reading		[ ]
	1st reading	−	[ ]
	kwhs used in 24 hours	=	[ ]

4. Multiply the power used in 24 hours by 30 (days) to find the approximate number of kwhs used per month.

[ ]	x	30	=	[ ]
kwhs used in 24 hours		days		Number of kwhs per month

5. Explain why measuring the number of kwhs for 24 hours will not give you your exact monthly usage.

---

6. Use the rate schedule shown on STUDENT PAGE 4 to calculate the approximate cost of this month's electric bill.

Fixed customer charge . . . . [ ]

Enter the number of kwhs used at $.06 each (up to 240 kwhs if more than 240 enter 240)

[ ] x $.06 = ... + [ ]

Usage exceeding 240 kwhs at $.09 each

[ ] x $.09 = ... + [ ]

TOTAL BILL = [ ]

SIGNATURE OF PARENT: ____________________ 3.6

Using The Correct Meter Scale

(Reading Meters)

Electronics Math 4

USING THE CORRECT METER SCALE

TEACHER MATERIALS:

1. CONCEPTS OF TECHNIQUE:

a. What SKILL will this technique teach?

This technique will teach the skill of reading a meter scale.

b. What student learning problem(s) prompted the development of this technique?

Many electronics students have difficulty knowing which set of numbers to read on a meter scale. They do not understand the concept of adding zeros or moving decimal places.

2. TEACHER INSTRUCTIONS FOR THE USE OF THIS TECHNIQUE:

a. Identify those students who have difficulty working with math and decimal numbers.

b. Use this technique to help prepare these students for your lesson on meter reading.

c. This technique may be used with the help of an advanced student.

d. Read the Information Handout to your students who need help.

e. Give these students the PRACTICE EXERCISE.

f. Have an advanced student check the answers.

g. Go over any missed problems.

h. Teach your regular lesson to ALL of your students.

3. SUGGESTED RELATED ACTIVITIES:

USING THE CORRECT METER SCALE

STUDENT MATERIALS:

1. STUDENT INSTRUCTIONS:

a. Read and study the two pages titled INFORMATION HANDOUT.

b. Answer the questions on the PRACTICE EXERCISE.

c. Have the teacher check your work.

d. Be sure to save the INFORMATION HANDOUT in your notebook because you will be working additional problems using this conversion method.

2. STUDENT ASSIGNMENT:

Your assignment is found on Student Pages 2-5.

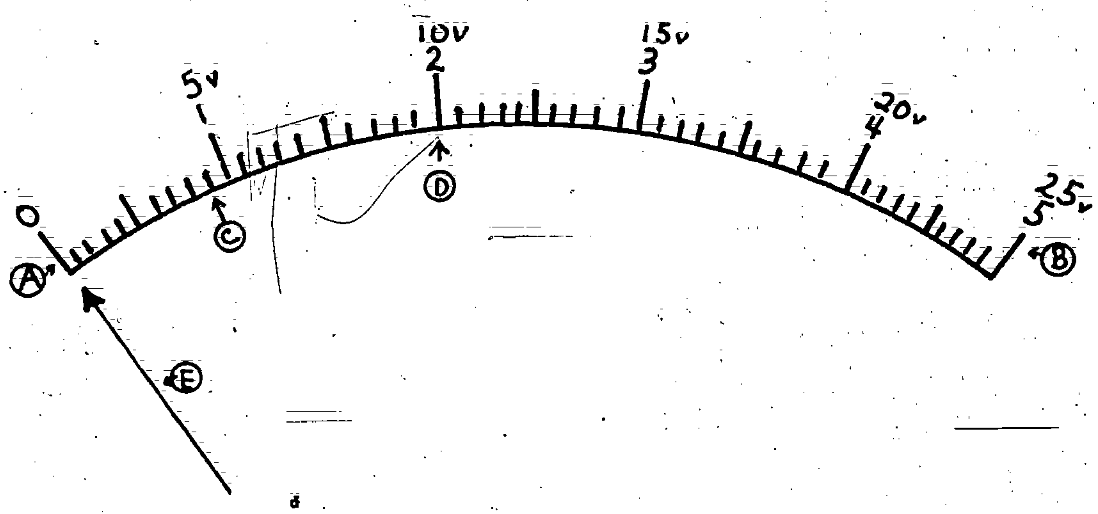
3. EXTRA THINGS THAT YOU CAN DO:

Ask your teacher if you can use a voltmeter and a power supply. Try reading the various voltages that the power supply can produce. Common voltages that you should try setting are 1.5 volts, 5 volts, 9 volts and 12 volts.

INFORMATION HANDOUT

USING THE CORRECT METER SCALE

In electronics you will frequently need to read a meter to determine how much voltage, current or resistance you have in a circuit. Accuracy is very important when using equipment that contains integrated circuits (IC). Setting a power supply even a few tenths of a volt too high will destroy an IC.



Important parts of a meter scale:

A. Zero: Where the pointer rests when nothing is applied to the meter.

B. Full Scale: The maximum point on a meter; exceeding this point can damage the meter.

C. Divisions or Division Marks: Short lines that divide the meter scale into small sections.

D. Major Divisions: Longer lines that divide the meter scale into larger sections. Major divisions have numbers next to them.

E. Pointer or Needle: Shows the point on the scale that a reading is to be taken.

USING THE CORRECT METER SCALE

The Range Switch on a voltmeter selects the maximum voltage that can be measured in each switch position. If the Range Switch is in the 5 volt position then voltages up to 5 volts can be measured.

The same meter scale is often used for many ranges. The meter scale on the previous page belongs on a voltmeter that has the following ranges: 5v, 25v, 50v, 250v, and 500v. The major divisions on this meter scale have two sets of numbers. To get the correct reading you must use the right set of numbers. To do this you must know what range the meter is set on. If you are using the 5v range you would use the bottom set of numbers. Look at the full scale point. The "5" stands for 5 volts on the 5 volt range. Don't get confused by the "5" on the left side of the top set of numbers. You must look at the full scale point when deciding which set of numbers to use.

To read the 25 volt range you would look at the full scale point and find the "25".

You must do something different if you want to read the scale for the 50 volt range. You will not find "50" on the scale. 50 volts is read on the same scale as 5 volts. This is done by adding a zero to the 5, making it 50. It is also necessary to add zero to the rest of the numbers on the scale. (1 becomes 10, 2 becomes 20, 3 becomes 30, 4 becomes 40)

For the 250 volt range you must add a zero to the 25 volt scale. (5 becomes 50, 10 becomes 100 15 becomes 150, 20 becomes 200, 25 becomes 250)

For the 500 volt range you must add two zeros to the 5 volt scale. (1 becomes 100, 2 becomes 200, 3 becomes 300, 4 becomes 400, 5 becomes 500)

If your meter had a 2500 volt range you would use the 25 volt scale and add two zeros.

Sometimes a meter will have a 2.5 volt range. It is not possible to make this scale by adding a zero. However, you can move the decimal place one position to the left. Remember that the number "25" is really "25.". If you move the decimal place in "25." one position to the left you will have "2.5". (5 becomes .5, 10 becomes 1.0, 15 becomes 1.5, 20 becomes 2.0)

It is even possible to get a .5 volt range by moving the decimal place on the 5 volt scale. (1 becomes .1, 2 becomes .2,

USING THE CORRECT METER SCALE

REVIEW

The 5 volt scale is used when you are on the .5v, 5v, 50v, 500v or 5000v ranges.

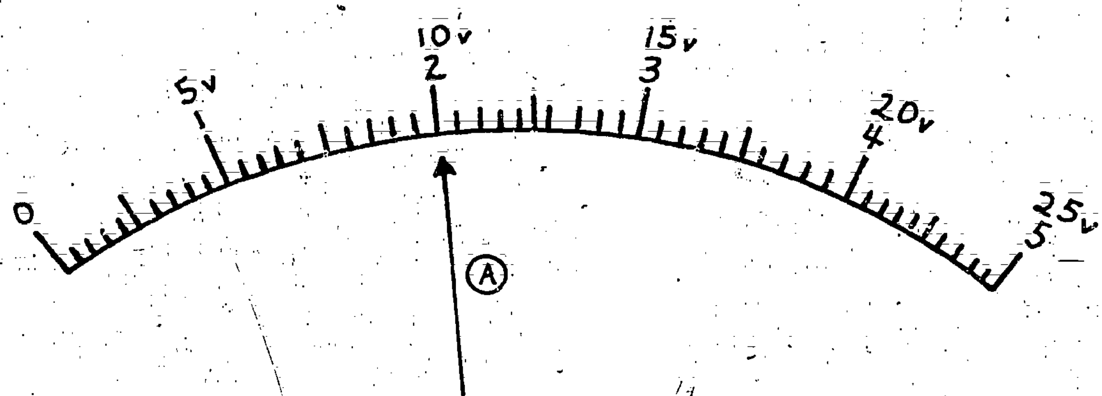
The 25 volt scale is used when you are on the 2.5v, 25v, 250v, or 2500v ranges.

Notice that the starting numbers are always the same. It is the number of zeros or decimal places that are changed.

When you change the full scale value by adding zeros, you must also change the other major division numbers by the same amount.

PRACTICE EXERCISE

USING THE CORRECT METER SCALE



Which scale would you use (5 or 25) to read each of the following ranges?

5v ________

25v ________

50v ________

250v ________

500v ________

If the pointer were in position A, what would the meter reading be on each of the following ranges?

5v ________

25v ________

50v ________

250v ________

500v ________

FINDING VOLTAGE DROPS IN A SERIES CIRCUIT

(Addition And Subtraction of Whole Numbers)

Electronics Math 5

7

FINDING VOLTAGE DROPS IN A SERIES CIRCUIT

TEACHER MATERIALS:

1. CONCEPTS OF TECHNIQUE:

a. What SKILL will this technique teach?

This technique will teach ADDITION and SUBTRACTION of WHOLE NUMBERS.

b. What student learning problem(s) prompted the development of this technique?

In electronics classes many students have trouble finding voltage drops in a series circuit when they are given the applied voltage.

2. TEACHER INSTRUCTIONS FOR THE USE OF THIS TECHNIQUE:

a. Teach your normal lesson on voltage drops in a series circuit.

b. Identify those students that are having difficulty in solving this type of problem.

c. Assign them the following pages. This assignment can be supervised either in the Math Lab or by an advanced student.

3. SUGGESTED RELATED ACTIVITIES:

This skill can be reinforced by having the student work problems that require finding the total resistance in a series circuit. The methods are the same as can be seen in the similarity in the formulas.

$$R_T = R_1 + R_2 + R_3$$

FINDING VOLTAGE DROPS IN A SERIES CIRCUIT

STUDENT MATERIALS:

1. STUDENT INSTRUCTIONS:

a. In electronics it is often necessary to determine how much voltage is in a circuit. It is not always possible to know all of the voltages. This technique will teach you how an electronic technician would determine an unknown voltage.

b. Please read and study the material in the INFORMATION HANDOUT.

c. When you have finished, answer the questions on the last page, and have your work checked by the teacher.

2. STUDENT ASSIGNMENT:

Your assignment is found on STUDENT PAGE 4.

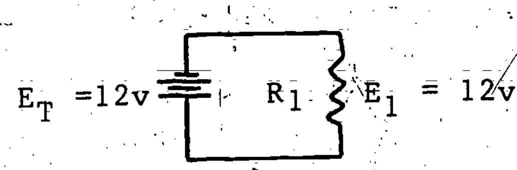
3. EXTRA THINGS THAT YOU CAN DO:

In this lesson you have practiced finding the voltage drops in series circuits. This is very similar to the methods you will use when you work problems where you must find an unknown resistance in a series circuit.

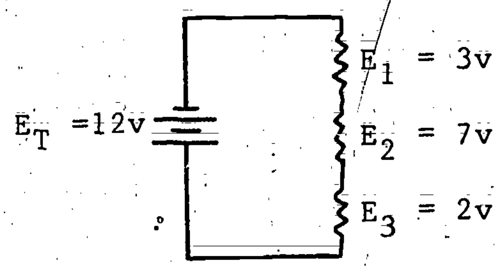
INFORMATION HANDOUT

FINDING VOLTAGE DROPS IN A SERIES CIRCUIT

Each time electricity (current) flows through a resistance some voltage is used. This used voltage is lost or DROPPED.



In the above schematic circuit there is only one resistor. The battery (E_T) is applying 12 volts to the circuit. The resistor (R_1) is DROPPING the entire voltage. Therefore, E_1 = 12 volts. All of the APPLIED (battery) voltage must be DROPPED in the circuit.



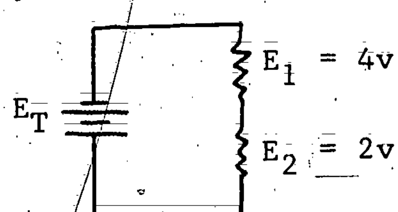
The second schematic circuit has 3 resistors. These are connected in a line. This is called a series circuit. Our battery voltage (E_T) again is 12 volts. All of this APPLIED 12 volts must be DROPPED in the circuit. Adding each of the individual voltage drops gives a sum of 12 volts.

(3v + 7v + 2v = 12v)

THEREFORE:
The sum of the individual voltage drops equals the applied voltage.

$$E_T = E_1 + E_2 + E_3$$

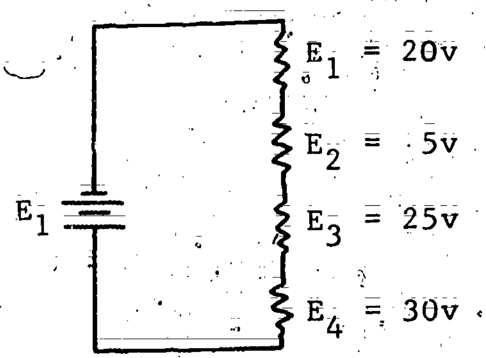
You can use this rule and formula to find the APPLIED voltage (E_T) whenever you know the individual voltage DROPS.



In this series circuit there are two voltage DROPS. You are given the voltage DROPS at E_1 and E_2.

The APPLIED voltage E_T equals E_1 (4v) plus E_2 (2v)

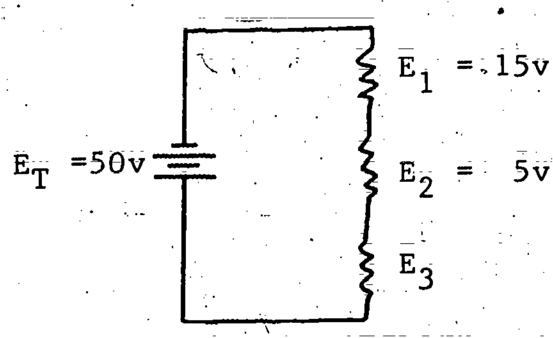
$$E_T = E_1 + E_2$$



In this series circuit the formula and solution would be:

$E_T = E_1 + E_2 + E_3 + E_4$
$E_T = 20v + 5v + 25v + 30v$
$E_T = 80v$

It is also possible to change the formula. This will allow you to find one of the individual voltage DROPS.



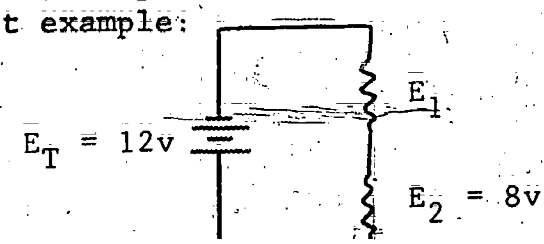
In this circuit the APPLIED voltage (E_T) is given. Voltage DROPS E_1 and E_2 are also given. However, E_3 is not known. By changing the formula you can determine the voltage E_3.

$E_3 = E_T - E_1 - E_2$
$E_3 = 50v - 15v - 5v$
$E_3 = 30v$

In this formula we subtracted the 15 volt DROP and the 5 volt DROP from the 50 volts that was APPLIED. This left E_3 = 30 volts.

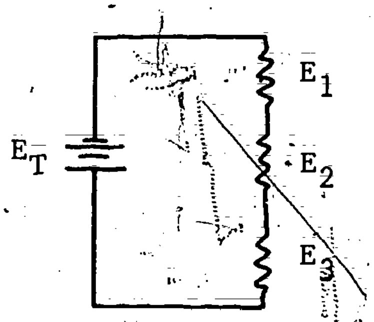
This formula will only work when you know all of the voltages except one.

One last example:



$E_1 = E_T - E_2$
$E_1 = 12v - 8v$
$E_1 = 4v$

FINDING VOLTAGE DROPS IN A SERIES CIRCUIT



Using the values given below find the APPLIED voltage.

1. E_1 = 10v, E_2 = 40v, E_3 = 30v

   E_T = ________

2. E_1 = 1v, E_2 = 10v, E_3 = 10v

   E_T = ________

3. E_1 = 40v, E_2 = 100v, E_3 = 7v

   E_T = ________

Using the values given below find the unknown voltage.

4. E_T = 60v, E_1 = 20v, E_2 = 30v

   E_3 = ________

5. E_T = 100v, E_1 = 40v, E_3 = 10v

   E_2 = ________

6. E_T = 150v, E_2 = 5v, E_3 = 12v

   E_1 = ________

POWER GAME

(Scientific Notation)

Electronics Math 6

POWER GAME

TEACHER MATERIALS:

1. CONCEPTS OF TECHNIQUE:

a. What SKILL with this technique teach?

This technique will teach the reading of decimals and powers of ten (scientific notation).

b. What student learning problem(s) prompted the development of this technique?

Many students enrolled in electronics classes have difficulty working with decimals and large numbers.

2. TEACHER INSTRUCTIONS FOR THE USE OF THIS TECHNIQUE:

a. Present your regular lesson on the powers of ten. Be sure to explain the following:

   1. Decimal place values .1, .01, .001, etc.

   2. Why powers of ten are used as a short cut method of expressing large or small numbers.

   3. The meaning of positive and negative powers of ten and the placement of the decimal.

   4. Multiplication and division of powers of ten. Include negative and positive powers.

b. Photocopy the attached ~~figures~~ on stiff paper or cardstock. Cut on the lines to form a deck of cards. Make up 5-6 sets of cards.

c. Your students will be instructed to shuffle the cards and play a game where they match up a given decimal or number with a power of ten card. Read the student instructions to your class.

d. Divide your class into groups with no more than 4 students in each group. Have one student act as dealer with the other students in the group helping the dealer make pairs. Have the groups play against each other to see which group can be the first to pair up the cards.

3. SUGGESTED RELATED ACTIVITIES:

Give your students the attached Scientific Notation Worksheet as-

POWER GAME

STUDENT MATERIALS:

1. STUDENT INSTRUCTIONS:

a. You will be given a set of cards. On each card there will be a decimal, a number, or power of ten.

b. Shuffle the deck well. Have one person in the group act as dealer. The rest of the group can help the dealer make pairs. The object of the game is to match the number or decimal card with the power of ten card.

c. To play, hold up the deck of cards in your hand with the numbers face up. Lay six cards on the table face up. Read each of the cards on the table aloud and see if there are any pairs. These are examples of matching cards:

10^{-1}	← pair →	$.1$
$\begin{array}{r} 4 \times 10^3 \\ \times\, 2 \times 10^4 \\ \hline ? \end{array}$	← pair →	8×10^7

d. As you make up pairs of cards put them in a separate pile. You must have six cards on the table at all times. As you make up pairs put more cards down in their place.

e. Look at each card in the deck. Say the number and see if it matches any card on the table. Continue doing this until you have paired up all the cards. At the end of the game you will have 24 pairs of cards.

2. STUDENT ASSIGNMENT:

Your teacher will give you the sets of cards for the game.

3. EXTRA THINGS THAT YOU CAN DO:

For extra credit ask your teacher for the Scientific Notation worksheet to do as homework.

WORKSHEET

SCIENTIFIC NOTATION

1. In the number 4^3, the "3" is called an ________________. — 1. [ ]

2. When using exponents of the number 10, the exponent is often called a _____ __ ___. — 2. [ ]

3. What is the numerical value of the expression 3^3? — 3. [ ]

4. To be in proper form, a scientific notation expression uses a number between A)________ and B)_______ times ten to a power. — 4A. [ ] 4B. [ ]

5. When converting the expression 7.6×10^{-3} to a regular number, the decimal point should be moved to the ______ three places. — 5. [ ]

Convert the following numbers, expressed in scientific notation, into "regular" numbers:

Figuring Space

6. 5×10^2 — 6. [ ]
7. 4.65×10^4 — 7. [ ]
8. 5×10^{-3} — 8. [ ]
9. 6×10^0 — 9. [ ]
10. 3.3×10^{-5} — 10. [ ]
11. 9.5755×10^3 — 11. [ ]
12. 2.125×10^{-2} — 12. [ ]

Convert the following "regular" numbers into <u>proper</u> scientific notation expression.

Figuring Space

13. 300 — 13. [ ]
14. 650000 — 14. [ ]
15. .0083 — 15. [ ]
16. .100 — 16. [ ]
17. 7 — 17. [ ]
18. .000000000012 — 18. [ ]
19. .0015 — 19. [ ]
20. 386.5 — 20. [ ]

$\begin{array}{r} 2 \times 10^4 \\ \times \; 3 \times 10^{-3} \\ \hline \end{array}$	4×10^1	1,000,000
6×10^1	40	1×10^6
1000	300	$\frac{8 \times 10^4}{2 \times 10^2}$

1×10^3	3×10^2	4×10^2
560	.4	.0001
5.6×10^2	4×10^{-1}	1×10^{-4}

.01	.001	.1
1×10^{-2}	1×10^{-3}	1×10^{-1}
$\dfrac{12 \times 10^2}{2 \times 10^2}$	5600	$\begin{array}{r} 4 \times 10^4 \\ \times\ 3 \times 10^4 \\ \hline \end{array}$

6	5.6×10^3	12×10^8
10	$\frac{8 \times 10^{-2}}{2 \times 10^2}$	1×10^1
4×10^{-4}	100	$\frac{8 \times 10^2}{2 \times 10^2}$

6.7

1×10^2	4	340
600	3.4×10^2	6×10^2
3400	10,000	3.4×10^3

6.8

1×10^4	$\dfrac{8 \times 10^4}{2 \times 10^{-2}}$	4×10^6

Conversion of Electrical Units

(Metric Conversion)

Electronics Math 7

CONVERSION OF ELECTRICAL UNITS

TEACHER MATERIALS:

1. CONCEPTS OF TECHNIQUE:

a. What SKILL will this technique teach?

This technique will teach the skill of converting one electrical unit to another using common electronic prefixes.

b. What student learning problem(s) prompted the development of this technique?

Many students enrolled in electronics classes have difficulty understanding the use of metric prefixes in electronic measure ments.

2. TEACHER INSTRUCTIONS FOR THE USE OF THIS TECHNIQUE:

a. Identify the students who have difficulty working with math and decimal numbers.

b. Use this technique to help prepare them prior to a lesson requiring the use of decimals or large numbers.

c. This technique may be used with the help of an advanced student or by the student alone.

d. Read and explain the Information Handout to your students that need help.

e. Give these students the worksheet.

f. Have an advanced student check the papers and go over any incorrect answers.

g. Teach your regular lesson to ALL of your students.

3. SUGGESTED RELATED ACTIVITIES:

Make up a bingo game where the squares are crossed off as the student figures the correct electrical conversion from problems you have given them.

CONVERSION OF ELECTRICAL UNITS

STUDENT MATERIALS:

1. STUDENT INSTRUCTIONS:

a. Read and study the two pages titled INFORMATION HANDOUT.

b. Answer the questions on the worksheet.

c. Have the teacher or another assigned student check your work.

d. Be sure to keep the INFORMATION HANDOUT in your notebook because you will be working additional problems using this conversion method.

2. STUDENT ASSIGNMENT:

2 - 6

Your assignment is found on Student Pages 2-6.

3. EXTRA THINGS THAT YOU CAN DO:

You may be able to use "Conversion of Electrical Units" in your math class.

INFORMATION HANDOUT

CONVERSION OF ELECTRICAL UNITS

There are six common prefixes or subunits used with electrical measurements. These units (mega, kilo, milli, micro, nano, and pico) provide a simple method for expressing very large or very small numbers without using scientific notation. Study the chart below and learn the meaning and relationship among the various units.

PREFIX	ABBREVIATION	POWER OF 10 EQUIVALENT	NUMERICAL VALUE
Mega	M	10^6	1,000,000
Kilo	k	10^3	1,000
BASIC UNIT (volts, amps, ohms, etc.)		10^0	1
Milli	m	10^{-3}	.001
Micro	μ	10^{-6}	.000001
Nano	n	10^{-9}	.000000001
Pico	p	10^{-12}	.000000000001

Thus: 1M is equal to 1×10^6 or 1,000,000.

2kV is the same as 2×10^3 V or 2,000V.

3mA can be written as 3×10^{-3}A or .003A.

4μV is equal to 4×10^{-6}V or .000004V.

5nA is the same as 5×10^{-9}A or .000000005A.

6pV can be written as 6×10^{-12} or .000000000006V.

Often it is necessary to convert from one electrical unit to another, especially when working with basic electrical formulas which require the electrical quantities to be in basic unit, or similar units (all in milli, etc.).

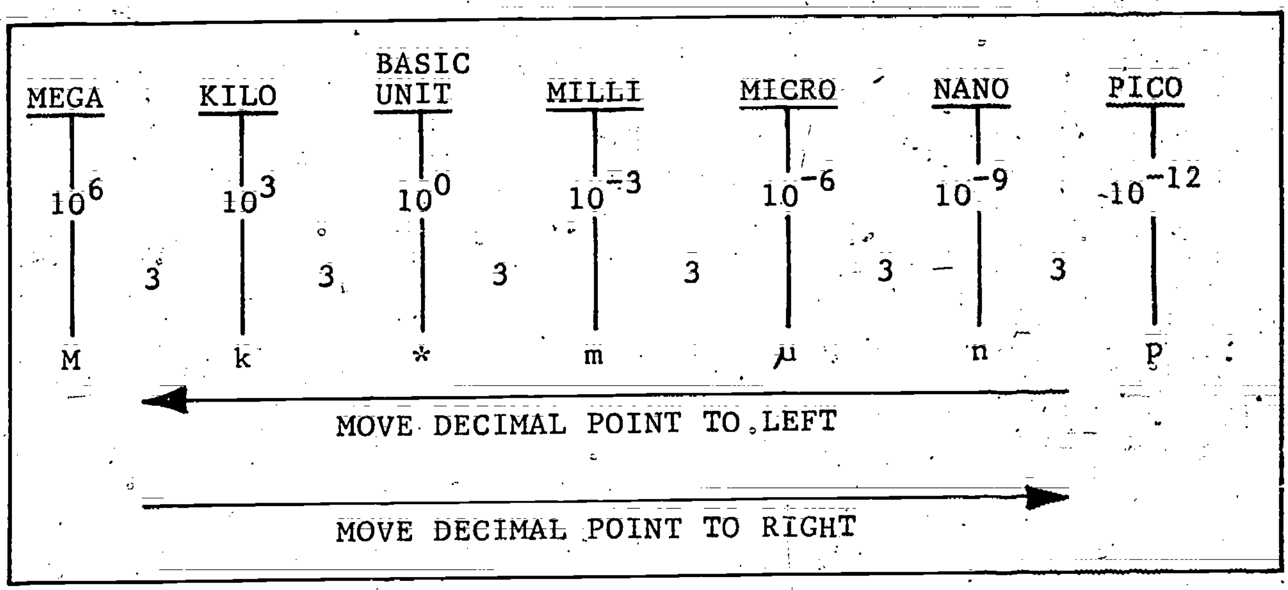
INFORMATION HANDOUT

CONVERSION OF ELECTRICAL UNITS

How would you convert 3kV to basic unit, or volts? Well, if you recall that kilo means thousand or 10^3, then it's easy to see that $3kV = 3 \times 10^3$ volts or 3000V. So actually, all that was done to convert from kilo to the basic unit was to move the decimal point 3 places to the right (3kV = 3 = 3000V). Likewise, if you are asked to change 3000V to kilo volts, all that need be done is to move the decimal point 3 places to the left. (3000V = 3 = 3kV).

The chart below can be used as an aid in performing electrical unit conversions. Notice that between each unit there are three decimal places.

CONVERSION CHART:



Steps in using the conversion chart:

When converting from one unit to another:

1) Count the number of decimal places from the "original" unit to the "desired" unit. (Remember, there are 3 decimal places between each unit.)

2) Determine the direction you want the decimal point to move. The decimal point will move in the same direction that you read across the chart, from your "original" unit to your "desired" unit. For example, if you are converting from kilo to milli the decimal point will be moved to the right, but if you are converting from micro to basic unit the decimal will be moved to the left.

3) Move the decimal point the number of places counted in step 1, and in the direction determined in step 2.

INFORMATION HANDOUT

CONVERSION OF ELECTRICAL UNITS

SAMPLE CONVERSIONS:

A. "25000 ohms is the same as ___________ kilohms."

This question is asking you to convert 25000 ohms (basic unit) to kilohms (kilo). Looking at the chart, count the number of decimal places between basic unit and kilo. You should come up with 3 decimal places. When counting, you start at "basic unit" and move to kilo - to the left across the chart. Thus, you will move the decimal point to the left 3 decimal places or

$$25000\Omega = 25.000 = \underline{25K\Omega}$$

B. "Convert .007A to ___________ mA"

Procedure: Move from "basic unit" to milli which is one unit to the right across the chart and therefore 3 decimal places to the right. Thus:

$$.007A = .007. = \underline{7mA}$$

C. "Convert 4.3µV to ___________ kV"

Procedure: Move from µ to k across the chart, which is 3 units, or 9 decimal places to the left. Thus:

$$4.3\mu V = .000000004.3 = \underline{.0000000043kV}$$

WORKSHEET

ELECTRICAL UNITS AND CONVERSIONS

Complete the chart below:

UNIT	ABBREVIATION	NUMERICAL POWER OF TEN	EQUIVALENT
MEGA			
	k		
BASIC UNIT			10^0
		.001	
			10^{-6}
NANO			
	p		

Use the CONVERSION CHART found on page 3 of the INFORMATION HANDOUT to help you perform electrical unit conversions.

Perform the following electrical unit conversions. Record your answers in the space provided and in the answer box.

1. 27,000,000 ohms is the same as ______ megaohms. 1.
2. 1 kilovolt is the same as ______ volts. 2.
3. 2,000 milliamperes is the same as ______ amperes. 3.
4. .1 megaohms is the same as ______ ohms. 4.
5. 9 amperes is the same as ______ milliamperes. 5.
6. 600 millivolts is the same as ______ volts. 6.
7. 250 microamperes is the same as ______ amperes. 7.
8. 850 microvolts is the same as ______ millivolts. 8.
9. .115 amperes is the same as ______ milliamperes. 9.
10. 60 kilohms is the same as ______ megaohms. 10.

WORKSHEET

ELECTRICAL UNITS AND CONVERSIONS

12. 49,000 picoamperes is the same as ________ microamperes. 12. [ ]

13. 5,000 microvolts is the same as ________ volts. 13. [ ]

14. 6 kilohms is the same as ________ ohms. 14. [ ]

15. .75 volts is the same as ________ microvolts. 15. [ ]

16. Convert 350,000Ω to kΩ. 16. [ ]

17. Convert .005A to mA. 17. [ ]

18. Convert .000061V to μV. 18. [ ]

19. Convert 485,000V to mV. 19. [ ]

20. Convert 75kΩ to Ω. 20. [ ]

21. Convert 153 mA to μA. 21. [ ]

22. Convert 62pV to mV. 22. [ ]

23. Convert 560Ω to kΩ. 23. [ ]

24. Convert 150 μA to A. 24. [ ]

25. Convert .09V to kV. 25. [ ]

USING MATHEMATICAL FORMULAS

(Algebraic Formulas)

Electronics Math 8

USING MATHEMATICAL FORMULAS

TEACHER MATERIALS:

1. CONCEPTS OF TECHNIQUE:

a. What SKILL will this technique teach?

This technique will teach the skill of using mathematical formulas to solve electronic problems.

b. What student learning problem(s) prompted the development of this technique?

Many students enrolled in electronics classes have not had a course on Algebra. Therefore, they have not been exposed to the use of formulas and the use of letters to represent numbers.

2. TEACHER INSTRUCTIONS FOR THE USE OF THE TECHNIQUE:

a. Identify those students who have not had previous experience in Algebra and/or the use of formulas.

b. Use this technique to help prepare these students prior to a lesson such as Ohm's Law.

c. Read and explain the Information Handout to these students.

d. Give these students the PRACTICE PAGE (STUDENT PAGE 5).

e. Check the PRACTICE PAGE and go over any missed problems.

f. Teach your regular lesson to ALL of your students.

3. SUGGESTED RELATED ACTIVITIES:

Have the students try using some other formulas where letters are used. For example:

A = L x W (Area = Length x Width)
C = P + T (Cost = Price + Tax)
Q = N x P (Quantity = Number of items x Price)

USING MATHEMATICAL FORMULAS

STUDENT MATERIALS:

1. STUDENT INSTRUCTIONS:

a. Understanding the use of formulas is very important in electronics. This packet will help you learn how to use mathematical formulas.

b. Read and study the two pages titled INFORMATION HANDOUT.

c. Answer the questions on the PRACTICE PAGE.

d. Have the teacher check your work.

2. STUDENT ASSIGNMENT:

Your assignment is found on STUDENT PAGE 5.

3. EXTRA THINGS THAT YOU CAN DO:

Have your teacher give you some non-electronic formulas to use.

What could the letters in these formulas stand for?

$$A = L \times W \qquad \text{or} \qquad R = \frac{D}{2}$$

INFORMATION HANDOUT

USING MATHEMATICAL FORMULAS

$$y = \frac{10 + z}{A}$$

The statement above is a mathematical formula.

You might think of a formula as a mathematical recipe. That is, by properly combining different ingredients together (numbers, operations, or variables) you will arrive at the desired results - a correct answer.

A mathematical formula tells you when to add, subtract, multiply or divide.

Whether a formula is simple or complex they have 4 things in common:

1) Unknown value: Generally abbreviated with a letter and located by itself on the left side of the equal sign. This is the value you are trying to find (answer to the problem).

2) Variable: A number, also abbreviated as a letter, but located on the right side of the equal sign. A variable changes and can be assigned many different values.

3) Constant: A number with a fixed value.

4) Mathematical Function: The mathematical operation to be performed, such as multiplication, division, addition, or subtraction.

EXAMPLE:

$$\underbrace{x}_{\text{unknown value}} = \underbrace{y}_{\text{variable}} \underbrace{+}_{\substack{\text{mathematical function}\\\text{(addition)}}} \overbrace{2}^{\text{constant}}$$

USING MATHEMATICAL FORMULAS

To find the unknown number in a formula you first fill in the numbers that are given or known and then you work the math function they ask for (add, subtract, etc.).

FOR EXAMPLE: What is X if Y = 6?

SAMPLE PROBLEM: $X = Y + 2$

If you are told that Y = 6 you can figure out what X is.

$$X = Y + 2$$

Since Y = 6 substitute the 6 for Y.

$$X = 6 + 2$$

Now you have to work the math function, you are told to add.

$$X = 6 + 2$$
$$X = 8$$

Study the sample problems below and you will see how to use a simple formula.

1. What is R if Y = 6?

   SAMPLE PROBLEM: $R = 4 + Y$

   Substitute 6 for Y.
   $$R = 4 + 6$$

   Add 4 + 6. $R = 10$

2. What is Q if S = 10 and D = 5?

   SAMPLE PROBLEM: $Q = 2 \times S + D$

   Substitute 10 for S and 5 for D.
   $$Q = 2 \times 10 + 5$$

   Multiply 2 x 10 and add 5.
   $$Q = 2 \times 10 + 5$$
   $$Q = 20 + 5$$

USING MATHEMATICAL FORMULAS

Try this problem on your own:

PROBLEM: What is E if $I = 5$ and $R = 100$?

$$E = I \times R$$

$$E =$$

$$E =$$

ANSWER: $E =$ ___

ANSWER: 500

USING MATHEMATICAL FORMULAS

PRACTICE PAGE

Try using what you have just learned. See if you can solve these problems without using the handout sheets. If you get stuck then look at your handout sheets. If you still need help, then go to the teacher.

1. $M = 5$

   $Z = M \times 2$

   $Z = \boxed{}$

2. $A = 21$

   $B = \frac{A}{3}$

   $B = \boxed{}$

3. $E = 12$ and $I = 6$

   $R = \frac{E}{I}$

   $R = \boxed{}$

4. $R = 8$ and $I = 4$

   $E = I \times R$

   $E = \boxed{}$

5. $R = 10$ and $E = 5$

   $I = \frac{E}{R}$

   $I = \boxed{}$

6. $R1 = 7$ and $R2 = 3$ and $R3 = 10$

   $RT =$

   $RT = \boxed{}$

THE FOLLOWING INDUSTRIAL EDUCATION BASIC SKILL INSTRUCTIONAL TECHNIQUES ARE AVAILABLE FROM:

VOICE (VOCATIONAL OCCUPATIONAL INFORMATION CENTER FOR EDUCATORS)

~~721 CAPITOL~~ MALL
SACRAMENTO, CALIFORNIA 95814

"LEARNING TO READ AND WRITE THE AUTOMOTIVE WAY"
"LEARNING TO DO MATH THE AUTOMOTIVE WAY"
"LEARNING TO VERBALLY & VISUALLY COMMUNICATE THE AUTOMOTIVE WAY"

"LEARNING TO READ AND WRITE THE WOODWORKING WAY"
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